

The invention claimed is:

1. A composite filter media for removal of particles from a fluid stream comprising:
  - a) a membrane filtration layer comprising a porous polymeric membrane, the membrane filtration layer having an upstream side and a downstream side relative to the direction of fluid flow; and
  - b) at least one depth filtration media layer comprising fibers, said fibers having an electrostatic charge, the at least one depth filtration media layer disposed on the upstream side of the membrane filtration layer.
- 10 2. The composite filter media of claim 1, in which the membrane filtration layer comprises ePTFE.
3. The composite filter media of claim 2, further comprising a support layer disposed on the downstream side of the membrane filtration layer.
- 15 4. The composite filter media of claim 3, in which the support layer is laminated to the membrane filtration layer.
5. The composite filter media of claim 2, in which the at least one depth filtration media layer comprises a non-woven fibrous polymeric web.
- 20 6. The composite filter media of claim 2, in which the membrane filtration layer further comprises filler material selected from the group consisting of carbon, carbon black, activated carbon, TiO<sub>2</sub>, platinum, colloidal silica, and fumed silica.
7. A renewable composite filter media for removal of particles from a fluid stream comprising:
  - a) a membrane filtration layer comprising a porous polymeric membrane, the membrane filtration layer having an upstream side and a downstream side relative to the direction of fluid flow;
  - b) a first depth filtration media layer having an upstream side and a downstream side relative to the direction of fluid flow, the first depth filtration media layer being disposed on the upstream side of the membrane filtration layer; and
- 25 30

- c) at least one additional depth filtration media layer removably attached to the upstream side of the first depth filtration media layer.
8. The renewable composite filter media of claim 7, in which the first depth filtration media layer is removably attached to the membrane filtration layer.
- 5       9. The renewable composite filter media of claim 7, in which the membrane filtration layer comprises ePTFE.
- 10      10. The renewable composite filter of claim 7, further comprising a support layer disposed on the downstream side of the membrane filtration layer.
- 10      11. The renewable composite filter of claim 10, in which the support layer is laminated to the membrane filtration layer.
12. The renewable composite filter media of claim 7, in which the depth filtration media layers comprise non-woven fibrous polymeric webs.
13. The renewable composite filter media of claim 12, wherein the non-woven fibrous polymeric webs further comprise charged fibers.
- 15      14. The renewable composite filter media of claim 7, in which the membrane filtration layer further comprises filler material selected from the group consisting of carbon, carbon black, activated carbon, TiO<sub>2</sub>, platinum, colloidal silica, and fumed silica.
- 20      15. The renewable composite filter media of claim 7, further comprising at least two additional depth filtration media layers removably attached to the upstream side of the first depth filtration media layer.
16. The renewable composite filter media of claim 7, further comprising at least three additional depth filtration media layers removably attached to the upstream side of the first depth filtration media layer.

17. The renewable composite filter media of claim 7, further comprising at least four additional depth filtration media layers removably attached to the upstream side of the first depth filtration media layer.
- 5        18. The renewable composite filter media of claim 7, in which the at least one depth filtration media layer further comprises a pattern of perforations whereby the at least one depth filtration media layer is removable by tearing at the perforations.
- 10      19. The renewable composite filter media of claim 7, in which at least one depth filtration media layer further comprises a first portion adjacent to the perimeter of the at least one depth filtration media layer and a second portion, the first portion being bonded to the filter media at a relatively higher strength than the second portion, whereby the at least one depth filtration media is removable by tearing away the second portion of the at least one depth filtration media layer from the first bonded portion.
- 15      20. The renewable composite filter media of claim 7, in which at least one depth filtration media layer is crush cut whereby the at least one depth filtration media is removable by tearing at the cut.
- 20      21. The renewable composite filter media of claim 7, in which the membrane filtration layer has a permeability of at least about 7 Frazier.
- 25      22. The renewable composite filter media of claim 7, in which the membrane filtration layer has a permeability of at least about 15 Frazier.
23. The renewable composite filter media of claim 7, in which the membrane filtration layer has a permeability of at least about 80 Frazier.
- 25      24. The renewable composite filter media of claim 7, in which each of the depth filtration media layers has a permeability of at least about 30 Frazier.
- 25      25. The renewable composite filter media of claim 7, in which each of the depth filtration media layers has a permeability of at least about 100 Frazier.

26. The renewable composite filter media of claim 7 in which each of the depth filtration media layers has a permeability of at least about 200 Frazier.
27. The renewable composite filter media of claim 7, in which the membrane filtration layer having an air permeability of about 10 Frazier to about 40 Frazier and a particle filtration efficiency of at least about 50% for 0.3 micron sized particles, and wherein the at least one removable filter layer has an air permeability of about 30 to about 200 Frazier and having a particle filtration efficiency of at least 50% for 0.3 micron sized particles.
28. The renewable composite filter media of claim 27, in which the membrane filtration layer has a particle filtration efficiency of at least 75% for 0.3 micron sized particles and wherein the at least one removable filter layer has an air permeability of about 60 to about 150 Frazier and a particle filtration efficiency of at least 85% for 0.3 micron sized particles.
29. The renewable composite filter media of claim 7 in which the membrane filtration layer and the depth filtration media layers are pleated such that the apices of the membrane filtration layer and depth filtration media layers are aligned.
30. The renewable filter media of claim 7 in which the filter media is shaped as a pleated panel.
31. The renewable composite filter media of claim 7 in which two edges of the filter media are joined to form a cylindrical filter media.
32. The renewable composite filter media of claim 7 in which the filter media is formed as a pleated cylinder.
33. A renewable composite filter media for removal of particles from a fluid stream comprising;
- a) a membrane filtration layer comprising a porous polymeric membrane, the membrane filtration layer having an upstream side and a downstream side relative to the direction of fluid flow;

- b) a support layer having an upstream side and a downstream side relative to the direction of fluid flow, the support layer disposed on the upstream side of the membrane filtration layer;
- 5           c) a first depth filtration media layer having an upstream side and a downstream side relative to the direction of fluid flow, the first depth filtration media layer disposed on the upstream side of the support layer; and
- d) at least one additional depth filtration media layer removably attached to the upstream side of the first depth filtration media layer.
- 10         34. The renewable composite filter media of claim 33, in which the membrane layer further comprises ePTFE.
35. The renewable composite filter media of claim 33, in which the first depth filtration media layer is removably attached to the support layer.
- 15         36. The renewable composite filter media of claim 33, in which the support layer is laminated to the membrane filtration layer.
37. The renewable composite filter media of claim 33, in which at least one depth filtration media layer is crush cut whereby the at least one depth filtration media is removable by tearing at the cut.
- 20         38. The renewable composite filter media of claim 33, in which the membrane filtration layer has a permeability of at least about 7 Frazier.
39. The renewable composite filter media of claim 33, in which the membrane filtration layer has a permeability of at least about 15 Frazier.
40. The renewable composite filter media of claim 33, in which the membrane filtration layer has a permeability of at least about 80 Frazier.
- 25         41. The renewable composite filter media of claim 33, in which each of the depth filtration media layers has a permeability of at least about 30 Frazier.

42. The renewable composite filter media of claim 33, in which each of the depth filtration media layers has a permeability of at least about 100 Frazier.
- 5           43. The renewable composite filter media of claim 33, in which each of the depth filtration media layers has a permeability of at least about 200 Frazier.
- 10           44. The renewable composite filter media of claim 33, in which the membrane filtration layer having an air permeability of about 10 Frazier to about 40 Frazier and a particle filtration efficiency of at least about 50% for 0.3 micron sized particles, and wherein the at least one removable filter layer has an air permeability of about 30 to about 200 Frazier and a particle filtration efficiency of at least 50% for 0.3 micron sized particles.
- 15           45. The renewable composite filter media of claim 44, in which the membrane filtration layer has a particle filtration efficiency of at least 75% for 0.3 micron sized particles and wherein the at least one removable filter layer has an air permeability of about 60 to about 150 Frazier and a particle filtration efficiency of at least 85% for 0.3 micron sized particles.
- 20           46. The renewable composite filter media of claim 33, in which the membrane filtration layer and the depth filtration media layers are pleated such that the apices of the membrane filtration layer and depth filtration media layers are aligned.
- 25           47. The renewable filter media of claim 33, in which the filter media is formed as a pleated panel.
48. The renewable composite filter media of claim 33, in which two edges of the filter media are joined to form a cylindrical filter media.
49. The renewable composite filter media of claim 33, in which the filter media is formed as a pleated cylinder.

50. A renewable composite filter for removal of particles from a fluid stream comprising:

- a) a frame; and
- b) a renewable composite filter media according to claim 7,

5 wherein the composite filter material is sealed in the frame with a potting material.

51. The renewable composite filter of claim 50, in which the potting material is selected from the group of silicone, polyurethane, epoxy, plastic adhesives and plastisol.

10 52. The renewable composite filter of claim 50, in which the filter frame further comprises a knife edge adjacent to the perimeter of the filter media whereby the at least one depth filtration media layer is removable by tearing the layer from the frame at the knife edge.

15 53. A renewable composite filter media according to claim 7, the renewable composite filter media having an initial pressure drop across the filter media and an initial filtration efficiency before use, in which the filter media is renewable after use by removal of a depth filtration media layer such that the pressure drop across the composite filter media upon removal is less than or equal to about the initial pressure drop across the filter media.

20 54. The renewable composite filter media of claim 53 in which the filtration efficiency after removal of the depth filtration media layer is about equal to the initial filtration efficiency.

25 55. A renewable composite filter media according to claim 7, the renewable composite filter media having an initial permeability and an initial filtration efficiency before use, in which the filter media is renewable after use by removal of a depth filtration media layer such that the permeability of the composite filter media upon removal is greater than or equal to 80% of the initial permeability.

56. The renewable filter of claim in which the filtration efficiency after removal  
of the depth filtration media layer is greater than about 85% of the initial  
filtration efficiency.

57. A renewable composite filter for removal of particles from a fluid stream,  
the renewable composite filter comprising:

- a) a filter frame;
- b) a pleated laminate comprising an ePTFE membrane and a support  
layer, the laminate having an upstream side and a downstream side  
relative to the direction of fluid flow, the laminate disposed within the  
10 frame and having an air permeability of about 3 Frazier to about 15  
Frazier, and a particle filtration efficiency of at least 90% for 0.3 micron  
sized particles;
- c) at least one pleated electrostatically charged melt blown filter media  
having an air permeability of about 30 Frazier to about 150 Frazier and  
15 a particle filtration efficiency of at least 50% for 0.3 micron sized  
particles, the at least one pleated electrostatically charged melt blown  
filter media disposed on the upstream side of the membrane such that  
the apices of the membrane and the melt blown filter are aligned, the  
melt blown filter media layer further comprising perforations adjacent to  
20 the frame; and

wherein the melt blown filter media is removable from the frame by  
tearing at the perforations.